SEASONAL CHANGES OF TROPICAL FOREST BIRDS IN THE SOUTHERN WESTERN GHATS[1]

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(*With seven text-figures*)

Key words: Seasonal changes, forest birds, Western Ghats, Kerala, India

A study was carried out in the tropical forests of Silent Valley and Mukkali in the Western Ghats, Kerala from May 1988 to April 1993, to elucidate the seasonal changes of bird communities in the two vegetation types. Abundance and density of birds were assessed, using variable width line transects each month. The highest populations, 609-1,892 /km^2 were found from December-April. Total number, monthly density and species richness of birds declined during monsoon. When compared, abundance and density of birds, observed in the evergreen forests was more (929 /km^2) than in moist deciduous forests (747 /km^2). However, bird population showed more stability in the moist deciduous forests. Except for two summers, significantly higher bird density was obtained in the evergreen forests during summer (1,074 /km^2). Bird species diversity was high during summer and low in monsoon in both the vegetation types. A direct negative relationship was also obtained between the rainfall, total number of birds, bird density and total number of bird species in the evergreen forests. Significant positive correlation was obtained between the temperature and bird community parameters in the evergreen forests, whereas rainfall and temperature showed no significant effect on the bird community in the tropical moist deciduous forests.

INTRODUCTION

Tropical forests support a stable population of birds in all seasons, whereas marked variations have been noted in temperate forests (Wright, 1970; Kricher, 1975). Seasonal variation of forest birds has been reported from several other countries (Anderson, 1972, Morrison *et al.* 1980, Pyke, 1984). No information, however, is available on the seasonal trends of tropical forest birds of the Western Ghats of South India. An attempt has been made to monitor the seasonal changes of bird communities in the tropical evergreen forests and the southern secondary moist mixed deciduous forest of Kerala. Birds of Kerala have been studied by Ali (1969), Ali and Ripley (1983a) and Ali and Ripley (1983b) earlier. Ecological studies were carried out at Silent Valley by Balagopalan (1990) and Balasubramanian (1990). Ramakrishnan (1983) studied the ecology of birds in the Malabar forests. Daniels (1989) and Daniels *et al.* (1990) reported many aspects of birds of the northern Western Ghats.

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STUDY AREA

Location and topography: The study areas, Silent Valley and Mukkali are located in Palakkad dist., Kerala State, between 11° 3' and 11° 13' N lat., and between 76° 25' and 76° 35' E long. They lie in the Western Ghats of south India and form part of the Nilgiri Biosphere Reserve (Fig. 1). After evaluating the entire area, two intensive study sites were selected: a tropical evergreen forest, Silent Valley, and a moist deciduous forest at Mukkali. The elevation of the study sites varied from 500 m to 1500 m above msl. The topography is undulating. According

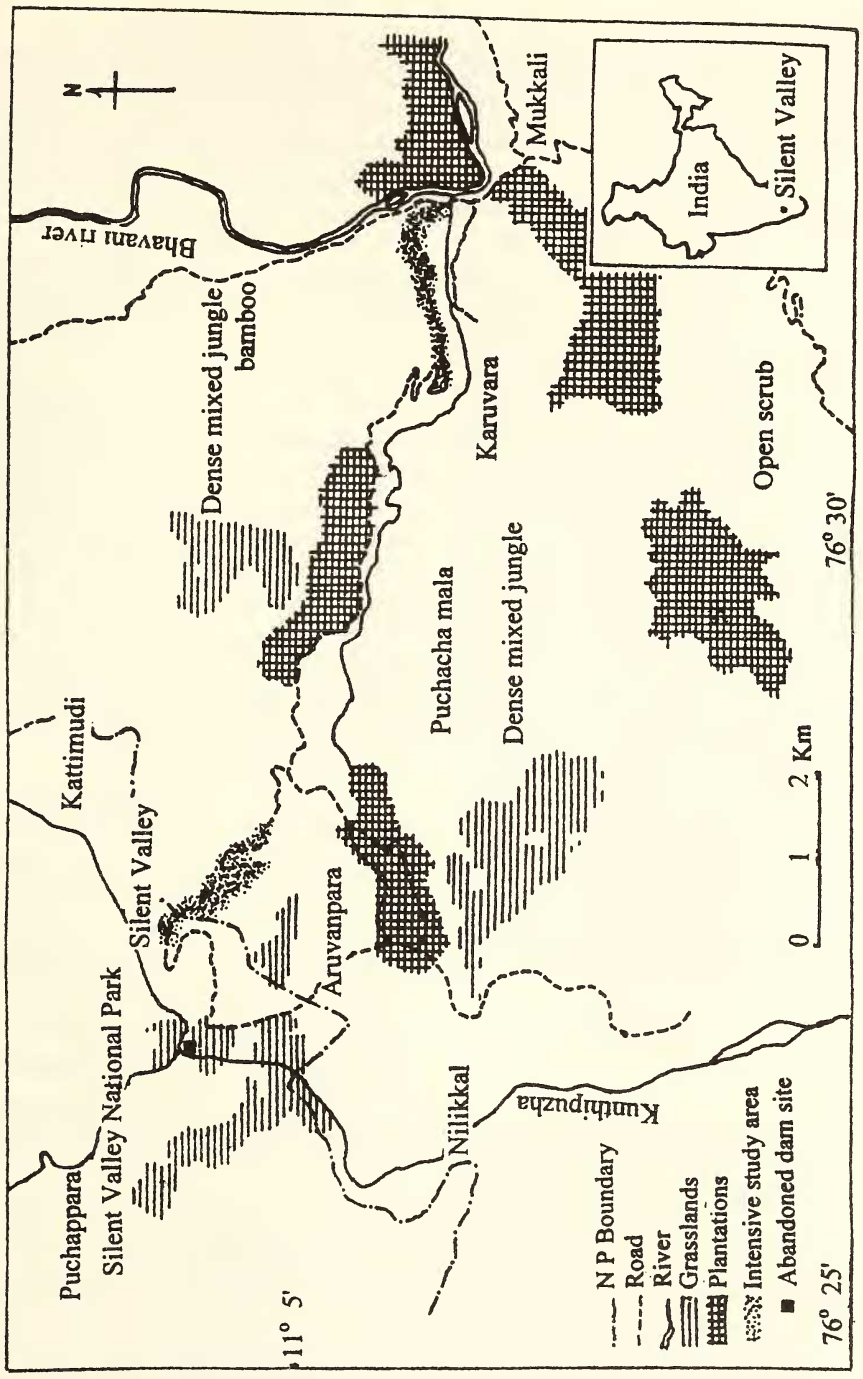

Fig. 1: Location of the study area

to Udvardy (1975), Silent Valley and Mukkali fall under the Malabar Rain Forest Realm. These two study sites are at a distance of about 20 km with a difference in elevation of 400 m between them.

Climate: There are two distinct seasons in the study area, monsoon starting from the end of May, up to mid-November, and the dry summer from December to April. Mukkali (4,227 mm/year) receives less rainfall compared to Silent Valley (5,096 mm/year). Heavy rainfall, 803 mm to 2,043 mm/month, was recorded at Silent Valley. From December to March, there is practically no rain. Temperature ranged from19°C to 22°C at Silent Valley and 21°C to 27°C at Mukkali.

Vegetation: A total of 966 species of angiosperms belonging to 559 genera and 134 families were recorded from Silent Valley and adjacent areas (Manilal, 1988). Pascal (1988) described the vegetation of the area as *Cullenia exarillata-Mesua ferrea-Palaquium ellipticum* type. It is characterised by the abundance of these three species, which may constitute about 80% of the large trees. Degraded areas and other vegetation types like grasslands are also common here. Vegetation of Mukkali is southern secondary moist mixed deciduous forest (Champion and Seth, 1968), degraded to some extent.

Methods

After considering all the available techniques, variable width line transect method described by Burnham *et al.* (1981) was adopted. Whenever a bird was spotted, it was identified up to the species level and details like the number of birds, perpendicular distance from the transect, height at which it is located in the canopy and habitat features were noted. Two line transects were selected, one at Silent Valley and the other at Mukkali; each transect was 4 km in length. The first transect covered evergreen forests and the second habitats like moist deciduous forests, rocky patches and fire burned moist deciduous forests. Census was started 30 minutes after sunrise in all the months. Transects were covered at a uniform speed. No census was done on days with very heavy rain and fog.

Two samples were collected from each area in a month. The second sample was started from the end of the first sample. A total of 150 samples were collected between May 1988 and 1993. No systematic data was collected on nocturnal birds. *All calls were considered as single individuals.* Perpendicular distances were measured approximately up to metres. To help distance assessment, known distances were measured and marked on trees using a Range Finder before the census. Abundance of birds in each month obtained from the census was used for analysis. Seasonal index of birds for each month was calculated using Time Series Analysis by the method of Simple Averages (Rao, 1983). The formula used is given below:

$$\text{Seasonal Index} = \frac{\text{Monthly average}}{\text{Sum of monthly averages}} \times 100$$

Analysis of variance was employed to find any significant difference existing in the total number of birds among the months. The Fourier Series Method was employed for calculating density from the ungrouped perpendicular distances from the transect. All the assumptions described by Burnham *et al.*(1981) were followed during the census. Students 't' test was applied to find out the significant difference in the number of birds between summer and monsoon. Diversity was calculated using Shannon-Wener Index ($H' = -\sum$ (pi ln pi) with the program SPECDIVERS.BAS developed by Ludwig and Reynolds (1988). Spearman Rank Correlation was used to find out the correlation between climatic parameters and bird community parameters.

TABLE 1
SEASONAL INDEX OF BIRDS PRESENT IN EACH MONTH AT SILENT VALLEY AND MUKKALI

Area	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Silent Valley	114	109	88	81	95	54	58	59	119	101	136	153
Mukkali	113	92	131	89	84	113	73	87	116	99	133	70

RESULTS

PATTERNS OF CHANGE

Monthly variation: During September to February, more birds were present at the Silent Valley compared to the annual average of 100 (Table 1). In Mukkali, higher number than the annual average were observed during the months of January, March, September and November. Highest Seasonal Index (133) was obtained in November. Analysis of variance showed a significant difference in the total number of birds among the months at Silent Valley ($F= 6.18$; $P= 0.01$), whereas no significant difference was obtained at Mukkali ($F= 1.95$; $P= 0.08$).

Seasonal variation in a year: The total number, monthly density and species richness of birds at Silent Valley and Mukkali declined during monsoon and increased in the dry months (Table 2). No significant difference in total number was obtained between monsoon and summer at Silent Valley and Mukkali (Silent Valley 't'=1.63, P=0.14; Mukkali 't'=0.28, P=0.79). Species like the black bulbul (*Hypsipetes madagascariensis*), emerald dove(*Chalcophaps indica*) and the imperial pigeon (*Ducula badia*) were practically absent during monsoon at Silent Valley.

Seasonal change over the years: Total number of birds: Data were pooled into two seasons, monsoon and summer, to find out the seasonal differences in the total number of birds over the years. Chi-square test revealed a significant difference in the number of birds between the seasons at Silent Valley (Table 3). The highest number of birds per month (91) was observed in the 1991 summer and the lowest (53) in the monsoon of 1992. At Mukkali, there was no significant difference among seasons in the total number of birds. Significant difference in the number of birds per month between Silent Valley and Mukkali was observed during three summers. During these seasons, there were more birds at Silent Valley. But during the 1992 summer and monsoon, no significant difference in the number of birds was observed, both at Silent Valley and Mukkali.

TABLE 2
COMMUNITY PARAMETERS OF BIRDS RECORDED DURING TWO SEASONS (1988-1993)

Area		Monsoon season	Summer season
Silent Valley	No. of birds (mean)	70.00 (±28.63)	90.33 (±32.25)
	Density (birds/km^2)	958.16 (±478.58)	1286.17 (±781.18)
	Species richness	28.33 (±6.87)	43.16 (±7.00)
Mukkali	No. of birds (mean)	60.67 (±12.61)	56.5 (±12.91)
	Density (birds/km^2)	854.33 (±400.43)	707.00 (±285.36)
	Species richness	30.67 (±9.35)	39.17 (±10.23)

Standard Deviation is in parenthesis

TABLE 3
MEAN NUMBER OF BIRDS RECORDED PER MONTH IN DIFFERENT SEASONS AT SILENT VALLEY AND MUKKALI

Seasons	Silent Valley	Mukkali	Total	X^2	P=
Monsoon 1988	70	76	146	0.25	NS
Summer 1989	95	52	147	12.58	0.02
Monsoon 1990	74	48	122	5.50	0.02
Summer 1991	91	50	141	11.92	0.001
Monsoon 1992	53	67	120	1.63	NS
Summer 1992	83	70	153	1.10	NS
Summer 1993	89	59	148	6.08	0.02
Total	555	422			
X^2	16.36	11.83			
P =	0.02	NS			

NS= Not Significant

Species Richness: There is no significant difference in bird species richness between years in monsoon (χ^2=4.26; P=0.05) and summer (χ^2=8.92; P=0.05) at Silent Valley. But a significant difference was obtained between years in both seasons at Mukkali (Monsoon χ^2 =38.97; P=0.001, Summer χ^2= 14.64; P=0.001).

Density: Significant difference in density was obtained between seasons in different years at Silent Valley and Mukkali. The values for summer and monsoon showed a significant difference (Silent Valley: χ^2=62.25, P=0.05, df=1; Mukkali: χ^2=39.33, P=0.05, df=1). Bird density was high during summer, both at Silent Valley and Mukkali. Except for two summers, significantly higher bird density was observed at Silent Valley in summer (Table 4).

Diversity: Variations in the diversity of birds, based on Shannon-Wener diversity index, in different seasons at Silent Valley and Mukkali are given in Table 5. Diversity index showed high values in summer ($\overline{X}$=3.12, n=5) and lower during monsoon ($\overline{X}$=2.65, n=4), at Silent Valley and Mukkali (monsoon: $\overline{X}$=2.78, n=4 and summer: $\overline{X}$=3.14, n=5).

TABLE 4
SEASONAL VARIATION IN BIRD DENSITY AT SILENT VALLEY AND MUKKALI

Seasons	Density/sq. km			Mean density		
	Silent Valley	Mukkali	Total	Mean	X^2	P =
Monsoon 1988	1036 (3.23)	638 (5.01)	1674	837	94.63	0.001
Summer 1989	2123 (2.21)	1662 (7.72)	3785	1892.5	56.15	0.001
Monsoon 1990	685 (3.03)	401 (7.86)	1086	543	74.27	0.001
Summer 1991	741.4 (3.93)	370 (14.99)	1111.4	555.7	124.11	0.001
Monsoon 1992	493 (9.11)	792 (3.06)	1285	642.5	69.57	0.001
Summer 1992	823 (6.03)	757 (4.34)	1580	790	2.76	NS
Summer 1993	608 (10.91)	688 (5.61)	1296	648.0	4.94	NS
Total	6509.40	5308				
X^2	1976.52	1471.29				
P =	0.001	0.001				

NS= Not Significant; The values in the brackets denote coefficient of variation of the estimates.

Factors affecting the seasonal variation

Rainfall: A direct relationship was obtained between rainfall and number of birds, density and total number of bird species at Silent Valley. When rainfall increased, all of these three community parameters decreased, and vice versa (Figs. 2, 3 & 4). At Mukkali also, rainfall had its influence on bird community, but not in the same magnitude as that of Silent Valley (Figs. 5, 6 & 7).

At Silent Valley, significant negative correlation was obtained between the mean of monthly total rainfall (1988-1993) and number

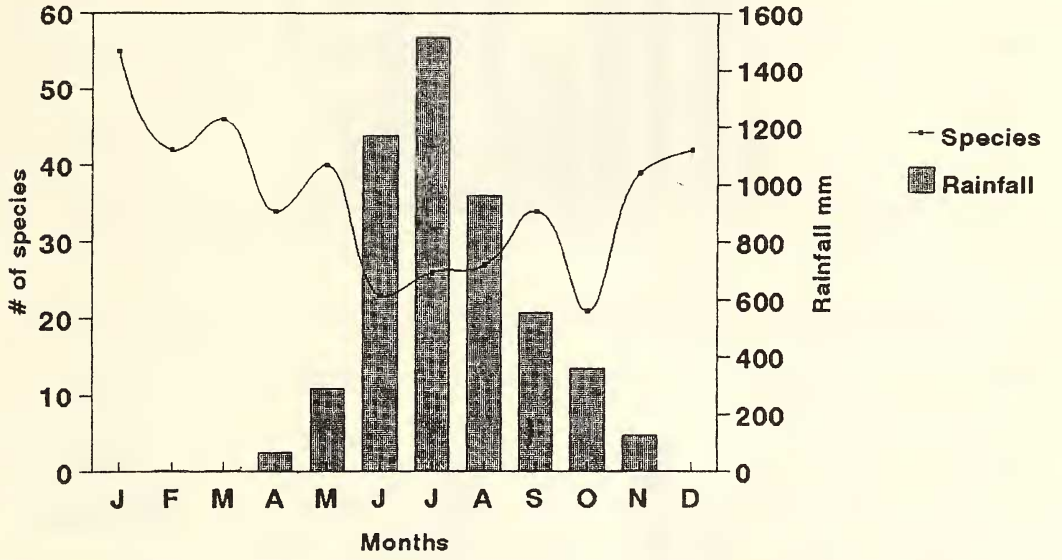

Fig. 2: Relation between rainfall and number of species at Silent Valley

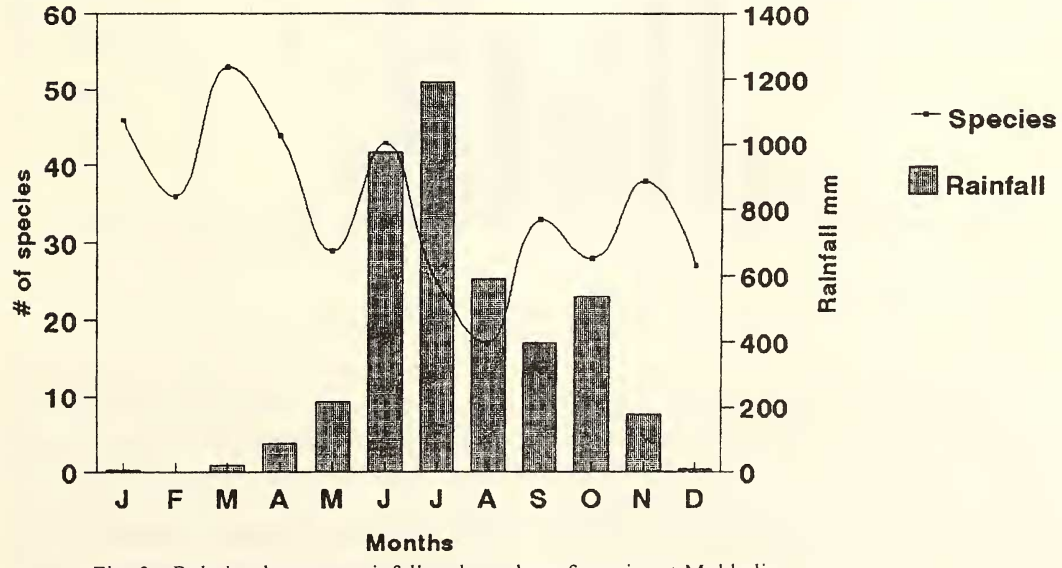

Fig. 3: Relation between rainfall and number of species at Mukkali

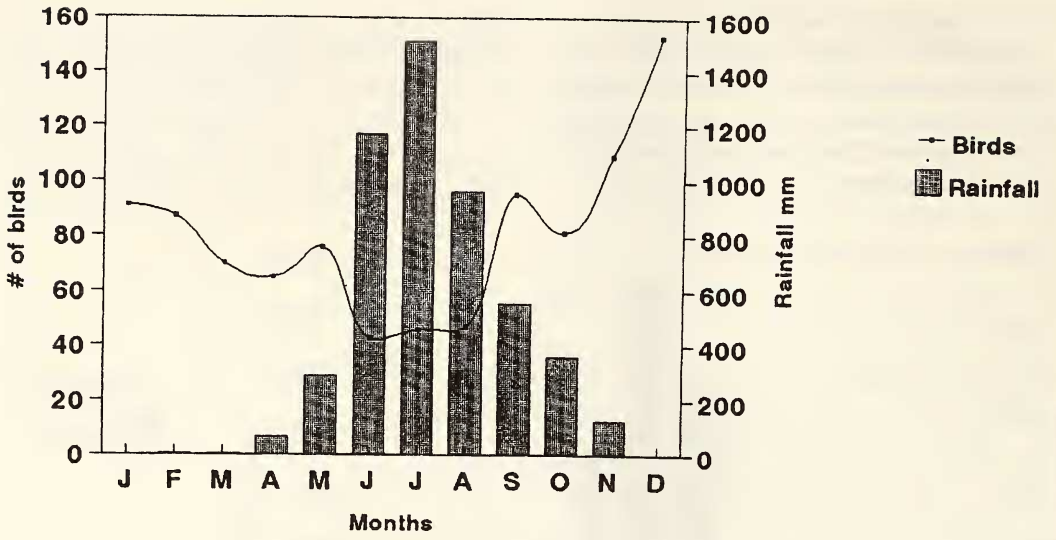

Fig. 4: Relation between rainfall and abundance of birds at Silent Valley

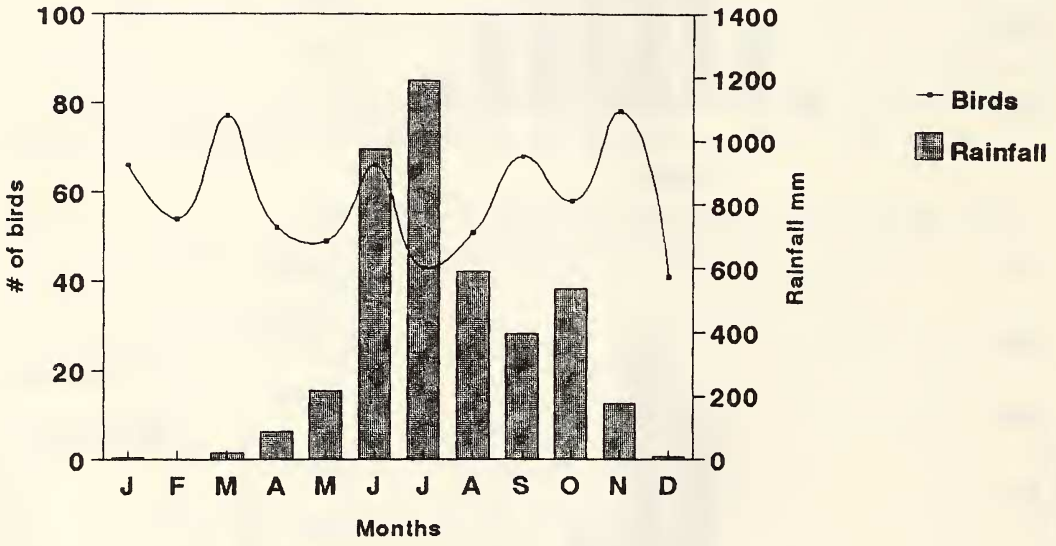

Fig. 5: Relation between rainfall and number of birds at Mukkali

of species in each month (r= -0.731, P= 0.01, n= 12). Significant correlation was also obtained between mean monthly rainfall and total number of birds in each month (r= -0.66, P= 0.05, n= 12). But there was no significant correlation between the density of birds in each month and rainfall (r= -0.45, P= 0.05, n= 12).

At Mukkali, no significant correlation was obtained between monthly rainfall and bird community parameters. Here, monthly rainfall showed negative correlation with the number of bird species (r= -0.41, P= 0.05, n= 12) and there was no significant correlation between monthly rainfall and the total number of birds (r= -0.21,

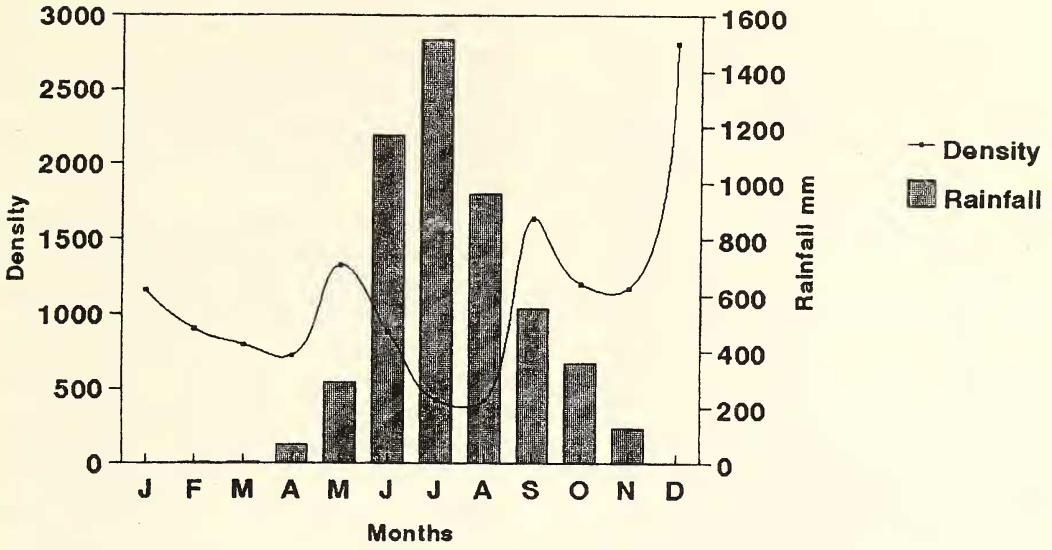

Fig. 6: Relation between rainfall and density of birds at Silent Valley

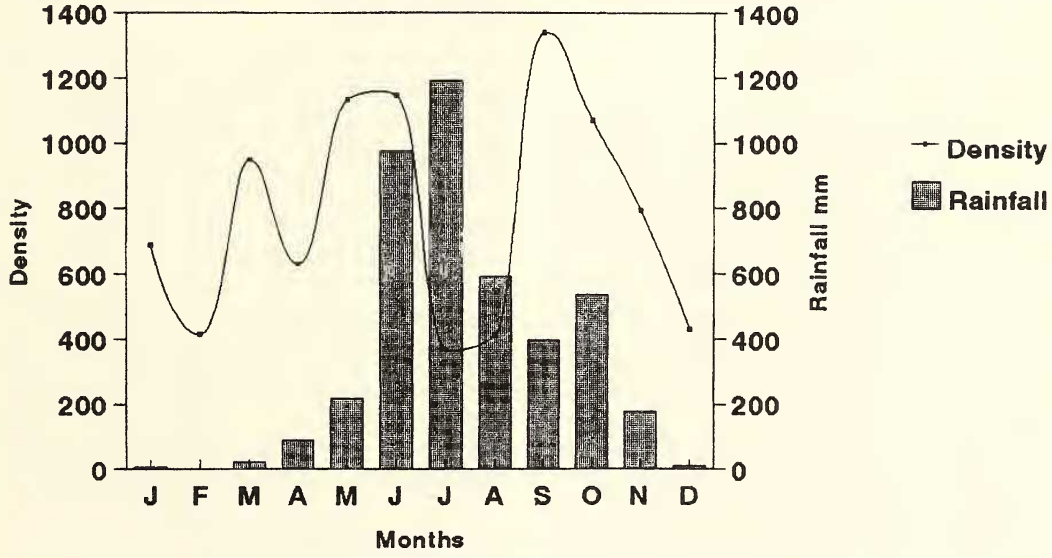

Fig. 7: Relation between rainfall and density of birds at Mukkali

P= 0.05, n=12) and their density (r= -0.06, P= 0.05, n= 12). This suggests that rainfall does not have any significant effect on the bird community at Mukkali.

Temperature: There was significant positive correlation between temperature and bird community parameters at Silent Valley. Number of species increased with increase in temperature (Coefficient of correlation r= 0.57, P= 0.05, n= 12). Similarly, total number of birds (r= 0.83, P= 0.001, n= 12) and their density (r= 0.62, P= 0.05, n= 12) showed an upward trend as the

TABLE 5
SEASONAL VARIATION IN DIVERSITY (H') AT SILENT VALLEY AND MUKKALI

Seasons	Silent Valley	Mukkali
Monsoon 1988	2.77	2.50
Monsoon 1989	2.38	2.63
Monsoon 1990	2.70	2.85
Monsoon 1992	2.74	3.13
Mean	2.65	2.78
Summer 1989	3.20	2.96
Summer 1990	3.01	2.95
Summer 1991	3.23	3.08
Summer 1992	3.29	3.46
Summer 1993	2.88	3.25
Mean	3.12	3.14

temperature increased during summer. At Mukkali, no such significant correlation was found (temperature and number of species r= 0.21, P= 0.05, n= 12; temperature and total number of birds r= -0.08, P= 0.05, n= 12).

DISCUSSION

Patterns of change: During monsoon, there was reduction in the number of birds both at Silent Valley and Mukkali. Birds appeared to move locally to avoid the unfavourable climate. Local movements in search of optimum habitats are possible because of the availability of other habitats in the vicinity as the tracts where the study was conducted were fragmented forest patches. Similar trends were reported from the tropical forests of other countries also. Variation in rainfall and soil moisture makes tropical bird fauna seasonal (Greenberg and Gradwohl, 1986). According to them, this is due to the influence of rainfall on phenological patterns of trees, which in turn affect the population trends of arthropods. Karr (1976) also showed the effect of high rainfall on the seasonal patterns of birds.

Higher numbers of birds were recorded during summer in two vegetation types. A greater abundance of birds was found at Silent Valley during summer than at Mukkali. Density of birds and their diversity indices were also higher for Silent Valley during summer, which can be attributed to the availability of more fruits at Silent Valley during summer. However, at Mukkali, the bird population showed much more stability.

Factors influencing the seasonal variations: Rainfall and temperature were the major factors influencing the abundance of birds at Silent Valley and Mukkali. Price (1979) who worked on the birds of Eastern Ghats also found a similar trend in annual cycles of bird fauna due to changes in rainfall. As mentioned earlier, a few species of birds like the yellowbrowed bulbul (*Hypsipetes indicus*) showed stability in population even in the fluctuating environment. This can be attributed to the resident nature of the species, coupled with its ability to feed on various food types like berries, drupes, nectar, spiders and insects.

Stiles (1978) had also shown that in tropical forests bird communities fluctuated in number as a response to the availability of food and climate changes. The relationship between food resources and bird diversity was also reported by Terborgh (1985). Even though tropical forest birds are considered sedentary, MacArthur (1972) has shown that seasonal movements are fundamental in many species as an adaptive strategy in varied forest habitats. This study also showed that rainfall and temperature influence the tropical evergreen forest bird community, whereas such climatic factors have little effect on birds of moist deciduous forests.

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